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DISTRIBUTION AND HISTOLOGICAL FEATURES OF SEBACEOUS AND SWEAT GLANDS IN DIFFERENT REGIONS OF THE SKIN OF TREE SQUIRRELS IN IBADAN, NIGERIA

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ABSTRACT

This study establishes distribution of sebaceous and sweat glands in different body regions of squirrels. A total number 10 apparently healthy squirrels were used for this study. Skin samples that were taken from selected regions of the body samples were histologically processed for microscopic examination. The slides were examined using the light microscope and histophotomicrography. Results reveal only two squirrels found to have sebaceous glands on their mouth parts with an average of approximately 1.88 ± 3.48 glands. Five having sebaceous glands on their head with an average of approximately 8.13 ± 9.82 glands. Four having sebaceous glands on their neck with an average of approximately 7.13 ± 9.03 glands. Four having sebaceous glands on their dorsum with an average of approximately 6.38 ± 5.93 glands. Seven having sebaceous glands on their ventral part with an average of approximately 7.13 ± 9.03 glands. Four having sebaceous glands at their tail with an average of approximately 4.75 ± 6.11 glands. One having sebaceous glands at their hind limb extremities with an average of approximately 1.88 ± 5.30 glands per 42.46 mm² field area per squirrel respectively. We concluded that the distribution of the sebaceous gland on the body of the squirrel is widely generalised with seven out of ten squirrels having the glands at their ventral region compared with just one squirrel having the gland on their hind limb. Further investigation required to determine reasons for more glands on the head region compared to other regions of the Tree squirrel body.

KEYWORDS:- Distribution, Histology, Sebaceous glands, Tree Squirrels, Nigeria.

INTRODUCTION

The squirrels (Zenkereka insignis) are rodents belonging to the family Sciuridae. There are about 285 species of squirrels throughout the globes, which have been grouped into flying squirrels, arboreal squirrels and ground squirrels (Thorington *et al*., 2012). About nine species whose habitat involves ground to forest shed have been reported in Gabon (Mintsa *et al*., 2009). Most species live in tree crevices while some live in burrows in the ground. Epixerus ebii is an unstriped arboreal rainforest squirrel distinct by its bushy tail. It is the only specie of the genus Epixerus, but made of 3 sub species, Epixerus ebii ebii, Epixerus ebii jones and Epixerus ebii wilsoni (Simmons, 2005). They are predominantly found in West Africa and dominate the squirrels' species in the Southern part of Nigeria. They are commonly seen jumping from one palm tree to another looking for palm nuts to be fed on. They assist in the regeneration of forest and maintenance of ecosystem through their seed dispersal activities. They are equally economically important as eaters of planted grains and seedlings in the field as well as bush meat sources to rural dwellers (Ayo-Ajasa *et al*., 2015). The economic importance of this animals' specie can equally be equated to the economic importance of West African Dwarf goats as recently described by (Olaogun *et al*., 2022). The economic importance of game animals especially (African squirrels) as an alternative source of animal protein, their domestication and commercialization potential had been suggested by several workers, including (Idiong and Orok, 2008; Amusa *et al*., 2015), for consideration in recent and on-going research works. These numerous important economic benefits will require for the possible domestication of this wild animal as recommended in African Giant rats in some previous studies by (Olaogun *et al*.,2021; Olawuwo *et al*., 2020). The external environment and the animal is connected and interacted through the animals' integument and the underlying organs is protected from mechanical trauma and infection by the integument. Importance of skin been the largest organ of the body and it function as the first line of defense against external insults cannot be underestimated (Fuchs, 2016; Sotiropoulou and Blanpain, 2012). The functions of the skin include (1) mechanical protection, (2) defense against the external influence, (3) immunoregulation, (4) body fluid

regulation, (5) conservation of body water, (6) body temperature control (7) sensing of external stimuli. The skin is also of economic important as raw materials used in making human materials and house needs by the industry (ÖZFİLİZ *et al*., 2002). The epidermis of the skin in development gives rise to three primary appendages, which are eccrine sweat glands, hair follicles and sebaceous glands (Biggs and Mikkola, 2014; Fuchs, 2016). These glands vary in their distribution structure and functions in mammalian body. Glands are groups of cells in man and animals that synthesize substances such as sweat for release into body cavities or its outer surface (exocrine gland) or into the blood (endocrine gland). Anatomically, the hair follicle and sebaceous gland constitute the two integral parts of the pilosebaceous unit, which is found everywhere except the palms of the hands and soles of the feet (Frances and Niemann, 2012; Toth *et al*., 2011)

Generally, in mammals, sweat glands (apocrine) and sebaceous glands occur separately or in combination. When found in combination, secretions from sebaceous glands may provide a transfer medium for the sweat gland products (Monteiro-Riviere, 2010).

Sebaceous glands are essential accessory organs of the skin. Most of the sebaceous glands are located between the hair follicle and the arrector pili muscle, and consist of one or more vesicles as well as a common short duct. There is presence of sebaceous glands all over the entire skin surface, with the exception of the hands' palm and feet's soles with the highest densities on the scalp and face (Weng *et al.*, 2020). The primary responsibility of sebaceous glands is to secrete sebum and lubricate the skin. It is also extended to protection of the body against microorganisms by forming part of the body's integumentary system. It secretes a very slightly acidic film on the surface of the skin that acts as a barrier to infectious agents and other potential contaminants that may enter the skin. It also produces antioxidant effects from vitamin E which is the main component of the skin's antioxidant system (Packer *et al*., 1999). Many studies have proven that the rodent integumentary structure are habitat-adapted and rodents of same genus but with different habitat even possess varying integument properties (Ibe *et al*., 2014; Stewart *et al*., 2013). The properties of the skin can be altered by many predictors; these include: nutrition, climatic condition of the animals' habitat (humidity, temperature, etc.), the behavior of the animals and feeding habit. Therefore, strength or integrity and thickness of skin layers varies in different species, even the skin of various parts in an animal may vary regarding thickness, gland types and in presence and or density of hair follicles (Hildebrand *et al*., 1995). The density and pattern of distribution of sebaceous and sweat glands in dermis of skin perform essential function in developing heat stress resistance ability of human and animals. Morphological characteristics of some mammalian species have been previously described especially in ferret, camel, cat and various domestic animals by (Ansari-Renani *et al*., 2010; Martin *et al*., 2007; Zanna *et al*., 2015 and Raghav *et al.*, 2021) respectively. However, there is a paucity of data about the normal properties of the skin of squirrels especially, the African Tree squirrels' species. So, the current study was conducted to explain the histological structure of the skin of African tree squirrels captured from Ibadan city. The results obtained was therefore compared with the findings in other mammals and will be of utmost importance in future dermatological studies on the African squirrel. This finding will also be relevant in assisting wildlife biologists and conservationists in understanding the squirrel's adaptive physiology in the conservation strategic plan or policy and guide veterinarians in managing skin diseases in this specie. Outcome of this study has also contributed to the available information on developing archive of comparative rodent anatomy.

MATERIALS AND METHODS

Ethical consideration

The experimental procedure and permission to euthanize the animals for research purpose was approved by the Animal Research Ethics Committee of the Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria (ACUREC). Animal used for this study were managed based on the stipulated guide for the Care and Use of Laboratory Animals, 8thedition, National Research Council, USA (National Academic Press, Washington).

Animals

A total number 10 African squirrels were used for this work after they were physically examined and found to be healthy, alert and free from skin lesions, open wounds and obvious diseases. They were sacrificed within 24 hours of acquisition, after being humanely euthanized with twice (0.3mg/Kg body weight) the normal dosage (0.15mg/Kg body weight) of xylazine injection administered intramuscularly at the thigh region.

Experimental protocol

The experimental procedures according to the established protocol of (Ibe *et al*., 2014) were adopted for obtaining skin samples from selected regions of the body which included: the mouth part, the head, the neck, the dorsum, the ventrum, the base of tail, the forelimb, the fore extremity (paw), the hind limb, the hind limb extremity and the scrotal sac (in male), after which they were fixed with 10% formalin. These samples were then processed histologically into slide sections for microscopic examination. The slides were stained with hematoxylin and eosin stains and examined under light microscope and histomorphometries examination conducted on the slides.

Data analysis

All metric data obtained were expressed as mean ± SEM, and presented in charts

RESULTS

Distribution of sebaceous glands in different body regions of squirrel

The distribution of the sebaceous glands as revealed by this study indicates only two of the ten squirrels having sebaceous glands on their mouth part. Five having sebaceous glands in the region of the head, four having sebaceous glands in their neck region. Five having sebaceous glands in their dorsal region, seven possessed sebaceous glands in their ventral area. Four squirrels possessed sebaceous glands in their base of tail, six squirrels possessed sebaceous glands in their forelimbs, five possessed sebaceous glands in their fore extremities (paw), six having sebaceous glands on the hind limbs and just one squirrel having sebaceous glands on their hind limbs extremities (Chart 1).

Histological features of the mouth part

From the present study, variations in the distribution of sebaceous glands in different body regions of tree squirrels were observed. Only two squirrels were found to have sebaceous glands on their mouth parts with an average of approximately 1.88 ± 3.48 glands per 42.46 mm² field area per squirrel (Fig 1).

Histological features of the head

Section of the head region results indicate presence of sebaceous glands with an average of approximately 8.13 ± 9.82 glands per 42.46 mm² field area per squirrel in the head of only five squirrels (Fig 2).

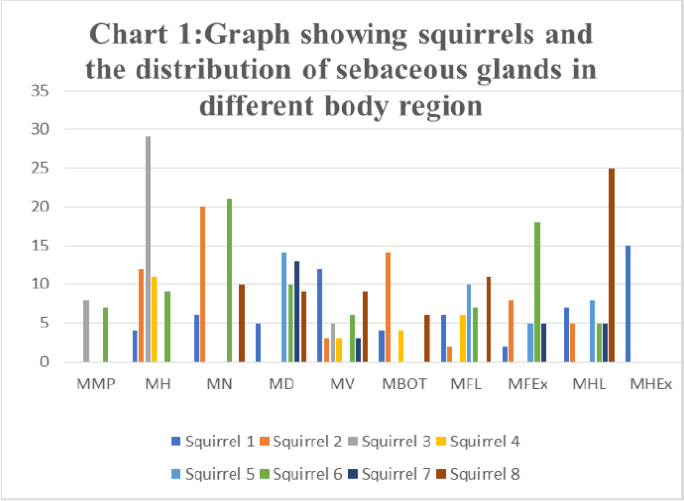
Histological features of the neck region

Sebaceous glands were found to be present on the neck region of only four of the squirrels with an average of approximately 7.13 ± 9.03 glands per 42.46 mm² field area per squirrel (Fig 3).

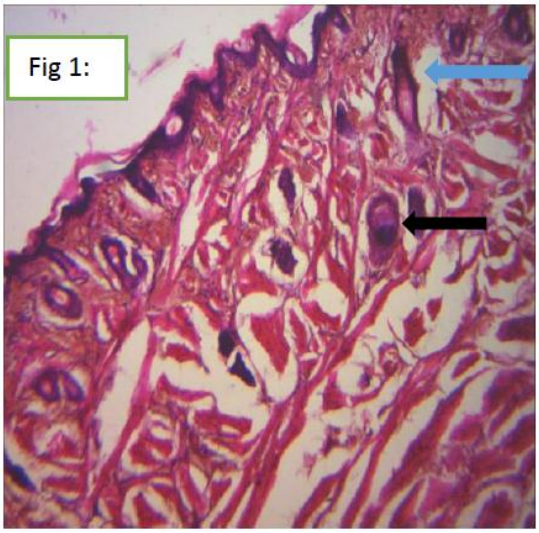
Histological features of the other body regions

Four squirrels demonstrated sebaceous glands in their dorsal part with an average of approximately 6.38 ± 5.93 glands per 42.46 mm² field area per squirrel (Fig 4). Sebaceous glands were found to be present on the ventral region of seven of the squirrels with an average of approximately 7.13 ± 9.03 glands per 42.46 mm² field area per squirrel (Fig 5).

Six squirrels were observed to show the glands on their fore limbs with an average of approximately 5.25 ± 4.23 glands per 42.46 mm² field area per squirrel (Fig 6). Sweat glands were demonstrated in the hind limb extremity and fore limb of some of the squirrels (Fig 7 & Fig 10). Micrograph results of the section of the fore limb extremity demonstrated variation in their sizes of sebaceous glands with some hair follicles reflected (Fig 8). Hind limb extremity results reveal sebaceous glands in only one squirrel of the ten squirrels with an average of approximately 1.88 ± 5.30 glands per 42.46 mm² field area per squirrel (Fig 9). The base of the tail section micrograph results revealed presence of sebaceous glands with an average of approximately 4.75 ± 6.11 glands per 42.46 mm² field area per squirrel in four squirrels (Fig 11).



Keys:
MMP: Mouth part
MH: Head region
MN: Neck region
MD: Dorsum
MV: Ventrum
MBOT: Base of tail
MFL: Fore limb
MFEx: Fore limb extremity
MHL: Hind limb
MHEx: Hind limb Extremity



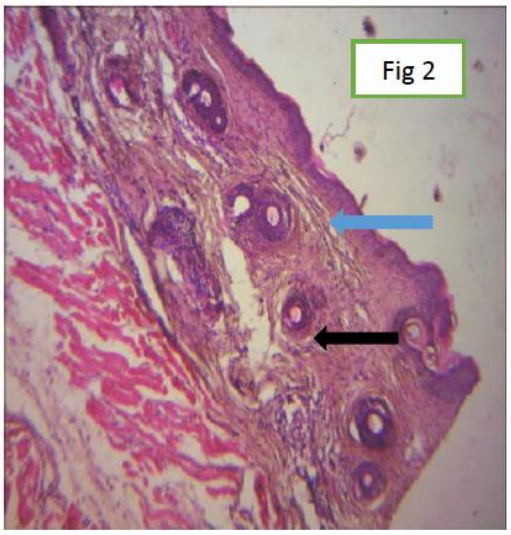
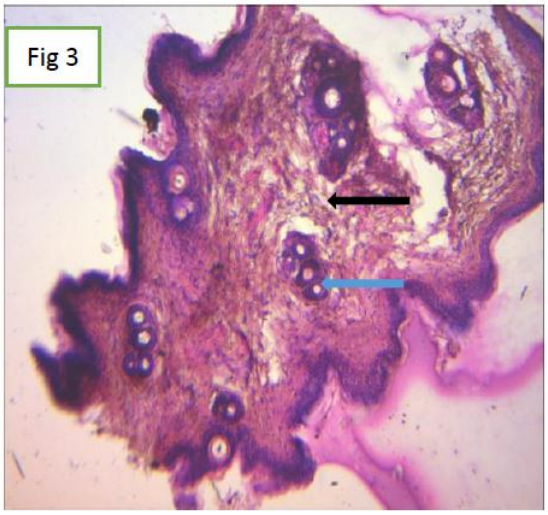


Figure 1: Section of the mouth part showing sebaceous glands (Black arrow) and Air follicles (blue arrow).
Figure 2: Section of the head region showing sebaceous glands (Black arrow) and Hair follicles (blue arrow).



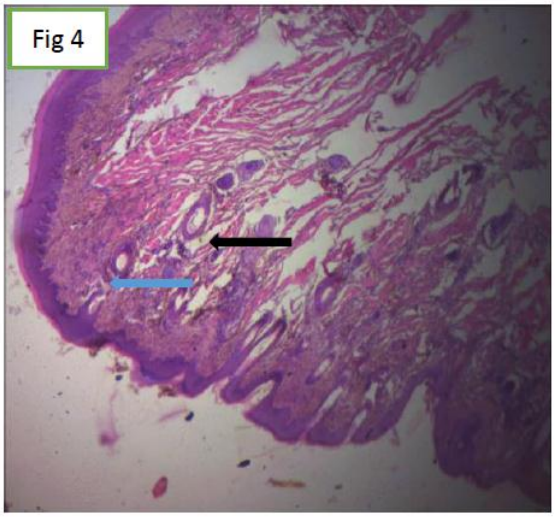
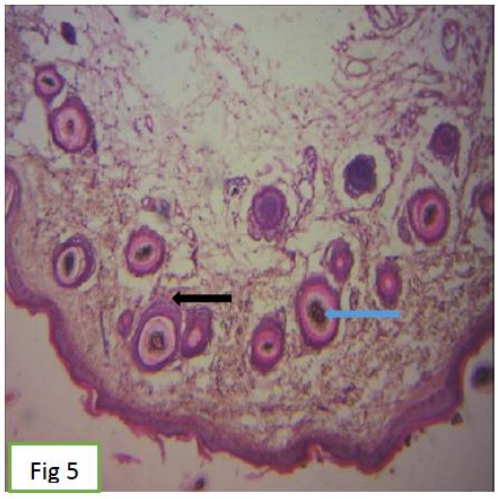


Figure 3: A section of the neck region showing sebaceous glands (Black arrow) and Compound hair follicles (blue arrow).
Figure 4: A section of the dorsal region showing sebaceous glands (Black arrow) and Hair follicles (blue arrow).



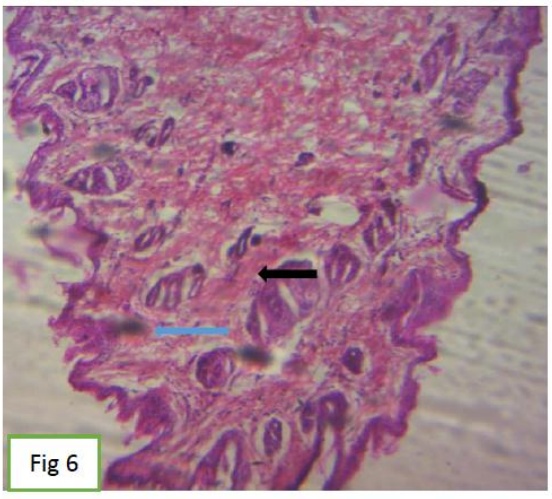
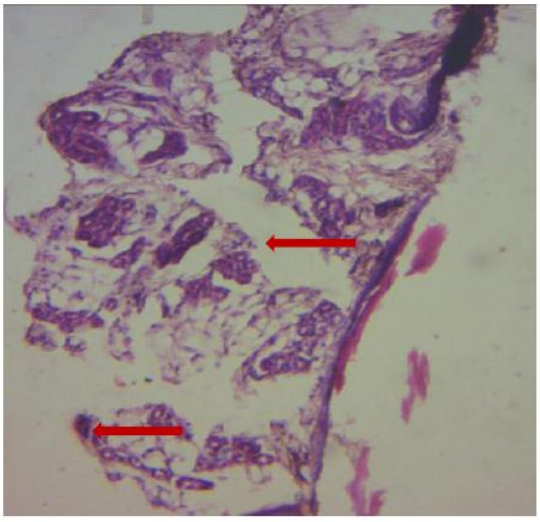


Figure 5: Ventral section showing sebaceous glands (Black) and Air follicles (blue arrow).
Figure 6: Hind limb section showing sebaceous glands (Black arrow) and Hair follicles (blue arrow).



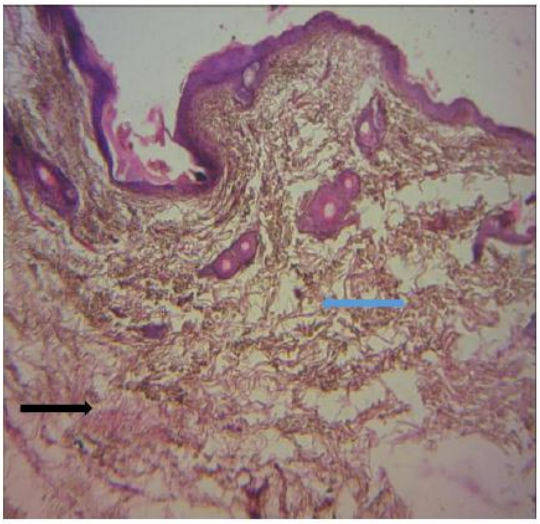
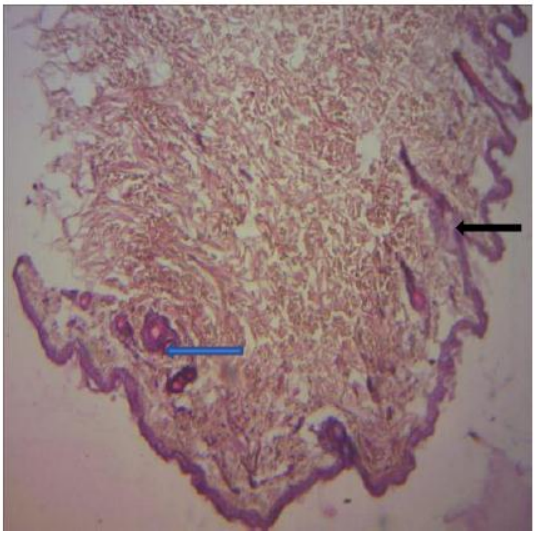


Fig. 7: Hind limb extremity section showing sweat glands.
Fig. 8: Fore limb extremity section showing sebaceous gland (Black) and Hair follicle (blue).



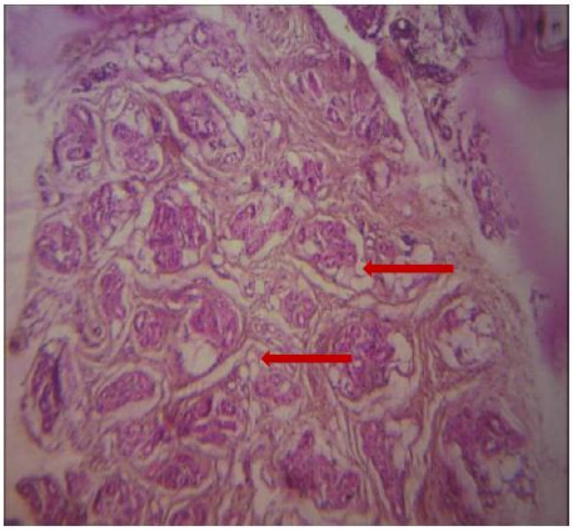


Fig. 9: A section of the hind limb showing sebaceous glands (Black arrow) and Hair follicles (blue arrow).
Fig. 10: A section of the fore limb showing sweat glands (red arrows).

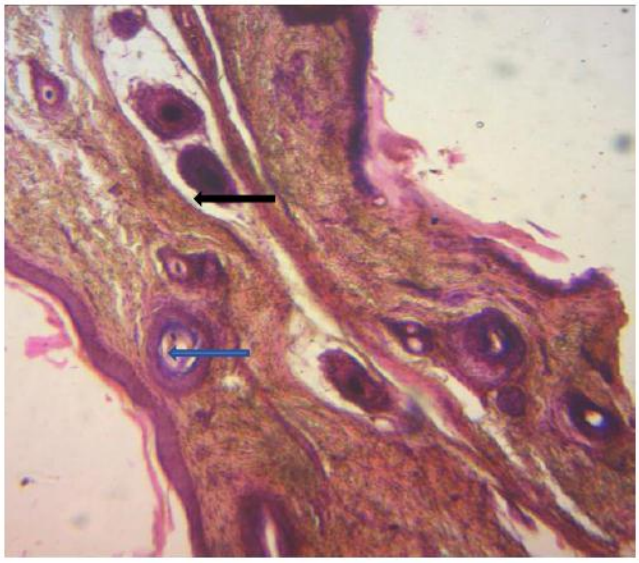


Figure 11: A section of the base of tail showing sebaceous glands (Black arrow) and Hair follicles (blue arrow).

DISCUSSION

In different species of squirrels, the location and distribution of skin glands have been reported to be closely related to positions that facilitate active and passive scent marking excluding the oral skin glands which are less well positioned for passive marking. A little effort is required to scent mark a particular substrate. (Kivett, 1978). The sebaceous glands are multilobular alveolar glands which comprised several layers of epithelial cells. These glands are associated with hair follicles in the squirrels studied. The duct of these glands opened into the hair follicles to form a pilosebaceous canal as also reported in buffalo (Debbarma *et al*., 2019), domestic animal (Dellmann, 1993), pigs (Sumena *et al*., 2010), sheep (Mamde *et al*., 2010 and Mobini *et al.*, 2012) Goat (Pathak *et al*., 2012) and cattle, buffalo, horse, goat, pig and dog (Raghav *et al*., 2021). There was solid mass of epidermal cells in the secretory units of glands. Sebaceous glands are evenly distributed over the body (Folk and Semken, 1991). They coat hair with sebum as it grows and are usually anatomically near an apocrine gland.

The presence of sebaceous glands near the root of the hair follicles as seen in this present study correlates with the findings of (Nagaraju *et al*.,2012), who reported that sebaceous glands were present at the base of hair follicle in skin of spotted deer, cattle and goat, but present in capsule with hair follicle and sweat glands in dog.

The presence of sebaceous glands, sweat glands and hair follicle observed in various part of the body of squirrels is in tandem with what had been previously described in other domestic animals by (Raghav *et al*., 2021). This wide spread distribution of sebaceous gland in squirrels may play important roles in their adaptability to environmental changes and their heat tolerance ability. In cattle and goat, sebaceous glands were generally present at the base of hair follicle. In dog, these sebaceous glands were arranged around compound hair follicles with one large primary follicle and eight to six secondary hair follicle along with sweat gland encapsulated with fibrous connective tissue. Of the nine body regions of the ten tree squirrels studied, the distribution of the sebaceous glands was found to be highest in the head and the least distribution pattern observed in the mouth part. This implies more serum distribution and better adaptive ability to heat stress in the head and neck regions than others with mouth and hind limb for least need of such functional disposition of such substance. The proper functioning of the entire body system of the animal without adequate adaptive ability to heat stress will be highly compromised leaving the animal in a high risk state of health. More concentration of sweat glands and adipocytes that were numerous around the dermis and hypodermis in the hind and fore limbs sections observed in this present study is similar to the previous observation of (Ibe *et al*., 2020). This may be associated with the involvement of limbs in general in pressure/load bearing and cushioning functions during jumping, eating, escaping and other activities.

CONCLUSION

The present study has demonstrated variations in the presence of sebaceous glands, sweat glands and hair follicles in the different body parts of the African squirrel. These variations may be factors responsible for their adaptation to the hot tropical forest climate this species of animal are adapted to. This study will be essential in the conservation of wild squirrel population and will be necessary to be considered when planning for the domestication of African squirrels. Further studies will be necessary in order to establish why we have variation in these glands in different body parts of African squirrel.

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